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(30)Priority

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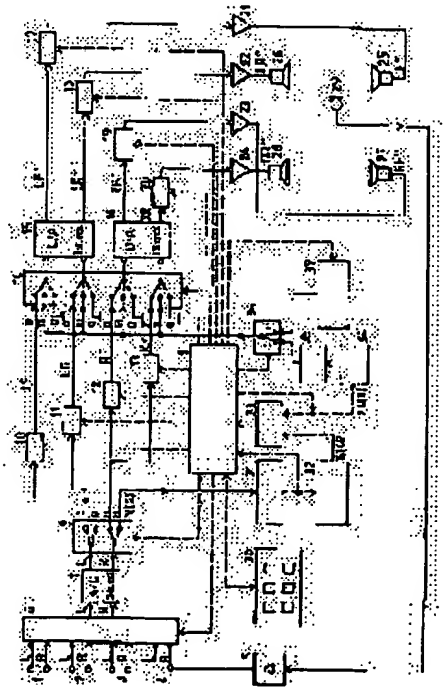
(54) STEREO REPRODUCING DEVICE

(57)Abstract:

PURPOSE: To automatically perform stereo reproduction at a listening place in different distances from plural speakers by measuring acoustic traveling time from the respective speakers to the listening place, adjusting and setting delay time and storing and controlling it.

CONSTITUTION: At a specified place surrounded by the speakers 25-28 inside a closed space, a microphone 29 is placed. By the operation of an operation unit 30, a controller switches this stereo reproducing device to an operation mode 'measurement' and starts the measurement. Measurement signals generated by a pulse generator 34 are measured as the acoustic traveling time by a traveling time measurement device 33 and the traveling time is immediately stored by a device 8. The device 8 stores the traveling time for all the speakers, operates the difference of the traveling time of the respective speakers and maximum acoustic traveling time and sets the delay time. Further,



the device 8 signal-outputs the respective delay time to respective delay devices 10-13 and automatically adjusts and sets a delay amount.

LEGAL STATUS

[Date of request for examination]	10.08.2001
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1 / 1

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] this invention relates to the equipment shown in the superordinate concept of the main claim.
[0002]
[Description of the Prior Art] People's acoustic sense is acquired from the evaluation of the level difference of an acoustic signal, and a transit-time difference which received the direction information with the ear of the right and the left. In the case of the ideal listening position in the so-called center of the stereo triangle which consists of a left loudspeaker, a right loudspeaker, and a listener, direction information ****s in stereo listening.
[0003] On the other hand, if a listener is asymmetrically located to two loudspeakers or multi-loudspeaker equipment, an acoustic impression (feeling of an image) will shift to the direction of the next loudspeaker remarkably spatially, respectively.
[0004] Removal is not usually carried out for the transit-time difference of the acoustic signal of each loudspeaker equipment to a level difference being manually removable with a conventional balance regulator and a conventional attenuator. However, these are important for direction listening by the sound mental principle of the first wave front.
[0005] Although some car radios which have delay transit-time equalization equipment are well-known, these car radios need the input of the distance following the measurement and it by the hand control of the distance of a listening place and a loudspeaker.
[0006]
[The technical problem which should solve invention] The technical problem of this invention is easy-izing setting adjustment of a time delay in the equipment shown in the superordinate concept of a claim 1.
[0007]
[Means for Solving the Problem] This technical problem is solved as follows by this invention. That is, the audio signal prepared in order to reproduce using each loudspeaker runs a delay unit, the time delay of this delay unit can be set up, a means to measure the sound transit time from each loudspeaker to a listening place is established, and this time delay is solved by the composition automatically set up so that the sum of the sound transit time and the time delay set up, respectively may become equal to all loudspeakers.
[0008] The equipment [easy-ize operation and also] by this invention has the following advantage further. That is, in consideration of the actual sound transit time, manual measurement for the sound way assumed between another side, and the loudspeaker of this ** and a listening place is carried out. In the case of the latter, reflection or directional change of an acoustic wave is not taken into consideration.
[0009] The equipment which is taken into consideration as follows according to the composition of the equipment by this invention, namely, measures the sound level which acts on a listening part by reproduction

of the measurement signal by each loudspeaker, for example, a noise signal, is formed, and the level difference in a listening place is taken into consideration by being automatically preset in the direction where the volume of each loudspeaker cancels a level difference.
[0010] According to another composition of the equipment by this invention, the time when it was set up for two or more listening places, and the preset value of volume as occasion demands are memorized in un-volatilizing.
[0011] In this case, the information on ****** is also memorized in un-volatilizing to a delay unit in the case of equipment's injection connection of any of the time delay memorized further and the volume preset value memorized if needed.
[0012] The car radio which has equipment by this invention by this composition is programmed as follows after measurement of the sound transit time for each seat position. That is, the optimization of reproduction is attained to each seat position by key press, and setting adjustment of the time delay which belongs to one predetermined seat position in the case of injection connection of equipment is carried out further. This seat position is usually an operator's seat position.
[0013] The signal processor of a digital formula is contained in many cases, the present receiving set, for example, car radio. in this case, according to the example of this invention, a delay unit is constituted by digital memory, and the audio signal which should be alike each time and should be delayed from a write-in point in time out of this digital memory is delayed in time, and is read
[0014] According to the example of this invention, digital memory is some digital audio signal processors, after measurement of the sound transit time Tx for all loudspeakers, the greatest sound transit time Tmax is chosen out of this, and each time delay is computed by formula Tax=(Tmax-Tx) -K. the time delay in the sampling cycle of an audio signal processor digital in Ta which should be set up and x -- each loudspeaker and K -- cycle period [of a processor] - it is the ratio of - by which the sound transit time Tx was measured in this period, and a sampling-cycle period [however,]
[0015] Conformity-ization to each arrangement of the loudspeaker and listening place of the equipment by this invention becomes possible by the next composition advantageously. namely, a measurement of the sound transit time sake -- succeeding one another -- each time -- alike -- a loudspeaker -- a pulse signal -- **** -- a timing-measurement machine starts simultaneously in him and this case, and this timing-measurement machine measures time until a sound level exceeds a predetermined threshold in a measurement microphone The next composition is prepared in order to avoid the overload of a loud-sound loudspeaker. That is, a pulse signal minds the 3rd low pass filter whose cut off frequency is 11kHz, and it is ********** to a loudspeaker. The pulse signal is realized by the square wave pulse of the length for at least 3ms.
[0016] Another conformity-ization is also carried out and memorized in the equipment by this invention other than automatic conformity adjustment to the sound transit time. for example, according to this invention, an audio signal runs the inside of a frequency characteristic equalizing circuit further, a means to measure this frequency characteristic is established between the loudspeaker and the measurement microphone, and this frequency characteristic equalizing circuit carries out setting adjustment according to a measurement result -- having -- difference -- the frequency characteristic of each loudspeaker which is alike each time and is set up is memorized for a listening place
[0017]
[Example] Next, the example of this invention is explained using a drawing.
[0018] The block diagram shown in drawing 1 shows the NF (low frequency) section of a car radio. This car radio has the input sides 1, 2, and 3 for receive sections 1, 2, and 3, a cassette player, and a CD player. To another input side 4 established for one [R] of the stereo signals, for example, a right signal, the signal of the microphone amplifier 5 is **********. Throughout an operating mode "measurement", the input transfer switch 6 is put on a position 4, therefore the signal of the microphone amplifier 5 is transmitted. In an operating mode "reproduction", a signal minds a transfer switch 6 from one of input sides 1, 2, or 3, and it is

********** to a stereo analog / digital converter 7. The input transfer switch 6 and the another below-mentioned transfer switch are controlled by the control unit 8.
[0019] The output side of an analog / digital converter 7 is connected with the input side of the double transfer switch 9 similarly controlled by the control unit 8. the audio signals L and R digitized in the top position of the double transfer switch 9 -- respectively -- the delay unit 10 of two good control, and 11; -- it reaches to 12 and 13 In a digital signal processor, it can realize as write-in read-out memory (RAM), or these can be connected to a data barrel signal processor outside. Access to memory is performed by internal address [of a digital signal processor] -, and the data control section. start - switching - and a level control -- the digital signal processor itself -- or it is carried out by the external microcontroller
[0020] The output signal of the delay unit of good control is prepared for the left front loudspeaker, the left rear loudspeaker, the right front loudspeaker, and the right rear loudspeaker, respectively, therefore is shown by LF, LR, RF, and RR. these signals -- the input side of the 4-fold transfer switch 14 -- **** -- the top position of him and 4-fold transfer switch -- setting -- two stereo digital to analog converters 15 and 16 -- **********
[0021] Output signal LF' of digital to analog converters 15 and 16, LR', RF', and RR' mind the volume control boxs 17, 18, 19, and 20 and power amplifier 21, 22, 23, and 24 of good control, and are ********** to loudspeakers 25, 26, 27, and 28 as signal LF", LR", RF", and RR". The measurement microphone 29 is attached in the seat position where it is [in an automobile] different from each other, and is connected with the input side of the microphone amplifier 5 in the listening place which is different from each other.
[0022] The operation display unit 30 is connected to the control unit 8 if needed [operation unit 30 -]. Besides the normal operation function by suitable key input, this unit can also perform measurement of the transit time and a sound level. The double transfer switch 9 is controlled in a bottom position for these operating modes "measurement." Furthermore, each switch of a period and the 4-fold transfer switch 14 of an operating mode "measurement" is controlled as follows, without depending mutually. namely, -- succeeding one another -- each time -- alike -- one of the transfer switches -- a mid gear (connection with a test signal pulse or a noise) -- taking -- other transfer switches -- bottom position - it is controlled to take - as which a signal is not inputted into each loudspeaker here Next, the measurement signal MESS which runs through signalling channels 29, 5, 4, 6, 7, and 9 continues to the level signal machine 31, and is ********** to the threshold discriminator 32. The output side is connected with the transit-time measuring instrument 33 which consists of counters substantially. This counter is started with a pulse generator 34 with a control unit, and is suspended by the output signal of the threshold discriminator 32.
[0023] The output side of a pulse generator is connected with the 1st input side of a transfer switch 36 through the low pass filter 35. The noise source 37 similarly controlled by the control unit 8 is connected to the 2nd input side of a transfer switch 36.
[0024] Drawing 2 is the sequence diagram of the program for the control unit 8 (drawing 1) of a throughout of the operating mode "reproduction" in form of having been simplified since an operating mode "measurement" was the control unit 8 (drawing 1) of a throughout. In an operating mode "reproduction" or the usual operation, the usual function, for example, the manual control of volume control boxs 17-20 and selection between input sides 1, 2, or 3, is attained. Transit-time - and the volume setting adjustment value which are furthermore beforehand stored in the operating mode "reproduction" for two or more listening places are read from the non-volatile memory of a control unit 8, and it is ********** to regulators 10-13, and 17-20. The double switch 9 and the 4-fold switch 14 are put on the top position 0.
[0025] The program section 41 which operates runs this function periodically. In this case, it is asked whether an acoustic measurement should be performed before each repeat. If this is inputted using the operating set 30, an operating mode "measurement" will operate by the output side of branching 42. In the program section 43, the volume measuring instruments 17-20 (drawing 1) are set to predetermined nominal value (middle volume). Let it be a premise for the operator to have moved the measurement microphone 29 (drawing 1) to

the 1st listening part which should be measured in this program furthermore.
[0026] Next, in the program section 44, an input transfer switch is switched to an input side 4, and the double transfer switch 6 is controlled further in a bottom position. 4-fold transfer switch is moved to Mid-position m for the channel which is alike each time and should be measured, and is moved to the bottom position u for still more nearly another channel Muting connection of the loudspeaker connected is made in this bottom position.
[0027] In 45, a transfer switch 36 is put on the left position 1, and another side, a pulse generator 34, and the transit-time measuring instrument 33 start it. If the sound level in a measurement microphone exceeds a predetermined threshold, a transit-time measuring instrument will be suspended in 46, and measured value will be memorized in a control unit 8 (drawing 1).
[0028] Next, in the program section 47, a switch 36 is moved to the right position r, and a noise source operates over the time for about 500ms. By 48, measurement of average noise level is performed over 200ms over a part of time window in a microphone using the level measuring instrument 31. This value is also memorized.
[0029] In 49, a program branches depending on whether all four channels were measured. When not measured, the program sections 44-49 are repeated for the following channel. However, when all four channels are measured, measured value TLF, TRF, TLR, and TRR (Lx) exists measured value TLF, TRF, TLR, and TRR (Tx) and for a sound level for the transit time of four channels.
[0030] Next, in the program section 50, the time delay to which it should be set for delay units 10-13 is computed by formula Tax=(Tmax-Tk) -K. the time delay [in / the sampling cycle of the audio signal processor of a digital format / in Ta] which should be set up and x -- each loudspeaker (LF, RF, LR, RR) and K -- cycle period / of a processor / - it is the ratio of - by which the sound transit time Tx was measured in this period, and a sampling-cycle period / however, From the measured transit time, the greatest sound transit time Tmax (it can set to a processor cycle) was found beforehand. Furthermore in the program section 49, the storage with four values and the data of the listening place of affiliation in a setup to the computed value and non-volatile memory of delay units 10-13 is performed.
[0031] In the program section 51, the suitable step for the measured loudness level of sound Lx is performed. Lmax is formed first. Next, Lax=Lmax-Lx is computed for the loudspeaker which is different from each other. As offset of fixation, four equalization level Lax is added to the loudness level of sound in each channel set up by the user, respectively. An output level is stored after the calculation for the listening place of affiliation in non-volatile memory.
[0032] Branching 52 is performed depending on whether still listening somewhere else should be measured. When it should not be measured, in 53, a volume setter is added to the offset searched for in the program 51, and is set to the value of an operating mode "measurement" which existed before operation-izing. The operation-ized input sides 1, 2, or 3 are again set up before measurement by further 53. Furthermore, other transfer switches are switched according to an operating mode "reproduction." Next, a program progresses to 41. however, - when still listening somewhere else should be measured -- a program is repeated for - performed by the input with this suitable from 43 after branching 52
[0033] Drawing 3 shows the automobile which has four loudspeakers 25, 26, 27, and 28 with an operator 61. The distance a, b, c, and d to each loudspeaker [head / of an operator] has the size which is different from each other. Therefore, the disadvantageous operation stated to the beginning appears. In the equipment by this invention, it is made the size with an equal effective distance to all loudspeakers which forms the impression of false acoustical listening using the delay units 10-13 (drawing 1) of good control. In this case, the loudspeaker 28 most located in the distance from an operator 61 maintains the distance d. Similarly another loudspeaker can give Distance d by delay transit-time equalization operation, and is seemingly located in position 25' on the periphery centering on an operator 61, 26', and 27'.

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MEANS

[Means for Solving the Problem] This technical problem is solved as follows by this invention. That is, the audio signal prepared in order to reproduce using each loudspeaker runs a delay unit, the time delay of this delay unit can be set up, a means to measure the sound transit time from each loudspeaker to a listening place is established, and this time delay is solved by the composition automatically set up so that the sum of the sound transit time and the time delay set up, respectively may become equal to all loudspeakers.
[0008] The equipment [easy-ize operation and also] by this invention has the following advantage further. That is, in consideration of the actual sound transit time, manual measurement for the sound way assumed between another side, and the loudspeaker of this ** and a listening place is carried out. In the case of the latter, reflection or directional change of an acoustic wave is not taken into consideration.
[0009] The equipment which is taken into consideration as follows according to the composition of the equipment by this invention, namely, measures the sound level which acts on a listening part by reproduction of the measurement signal by each loudspeaker, for example, a noise signal, is formed, and the level difference in a listening place is taken into consideration by being automatically preset in the direction where the volume of each loudspeaker cancels a level difference.
[0010] According to another composition of the equipment by this invention, the time when it was set up for two or more listening places, and the preset value of volume as occasion demands are memorized in un-volatilizing.
[0011] In this case, the information on ****** is also memorized in un-volatilizing to a delay unit in the case of equipment's injection connection of any of the time delay memorized further and the volume preset value memorized if needed.
[0012] The car radio which has equipment by this invention by this composition is programmed as follows after measurement of the sound transit time for each seat position. That is, the optimization of reproduction is attained to each seat position by key press, and setting adjustment of the time delay which belongs to one predetermined seat position in the case of injection connection of equipment is carried out further. This seat position is usually an operator's seat position.
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[0014] According to the example of this invention, digital memory is some digital audio signal processors, after measurement of the sound transit time Tx for all loudspeakers, the greatest sound transit time Tmax is chosen out of this, and each time delay is computed by formula Tax=(Tmax-Tx) -K. the time delay in the sampling cycle of an audio signal processor digital in Ta which should be set up and x -- each loudspeaker and K -- cycle period [of a processor] - it is the ratio of - by which the sound transit time Tx was measured in this period, and a sampling-cycle period [however,]

[0015] Conformity-ization to each arrangement of the loudspeaker and listening place of the equipment by this invention becomes possible by the next composition advantageously. namely, a measurement of the sound transit time sake -- succeeding one another -- each time -- alike -- a loudspeaker -- a pulse signal -- **** -- a timing-measurement machine starts simultaneously in him and this case, and this timing-measurement machine measures time until a sound level exceeds a predetermined threshold in a measurement microphone The next composition is prepared in order to avoid the overload of a loud-sound loudspeaker. That is, a pulse signal minds the 3rd low pass filter whose cut off frequency is 11kHz, and it is ********** to a loudspeaker. The pulse signal is realized by the square wave pulse of the length for at least 3ms.
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PRIOR ART

[Description of the Prior Art] People's acoustic sense is acquired from the evaluation of the level difference of an acoustic signal, and a transit-time difference which received the direction information with the ear of the right and the left. In the case of the ideal listening position in the so-called center of the stereo triangle which consists of a left loudspeaker, a right loudspeaker, and a listener, direction information ****s in stereo listening.

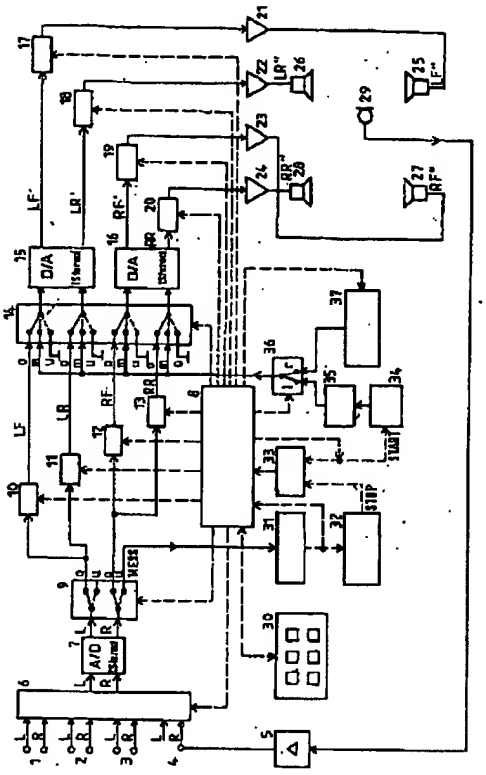
[0003] On the other hand, if a listener is asymmetrically located to two loudspeakers or multi-loudspeaker equipment, an acoustic impression (feeling of an image) will shift to the direction of the next loudspeaker remarkably spatially, respectively.

[0004] Removal is not usually carried out for the transit-time difference of the acoustic signal of each loudspeaker equipment to a level difference being manually removable with a conventional balance regulator and a conventional attenuator. However, these are important for direction listening by the sound mental principle of the first wave front.

[0005] Although some car radios which have delay transit-time equalization equipment are well-known, these car radios need the input of the distance following the measurement and it by the hand control of the distance of a listening place and a loudspeaker.

[Translation done.]

Drawing selection drawing 2



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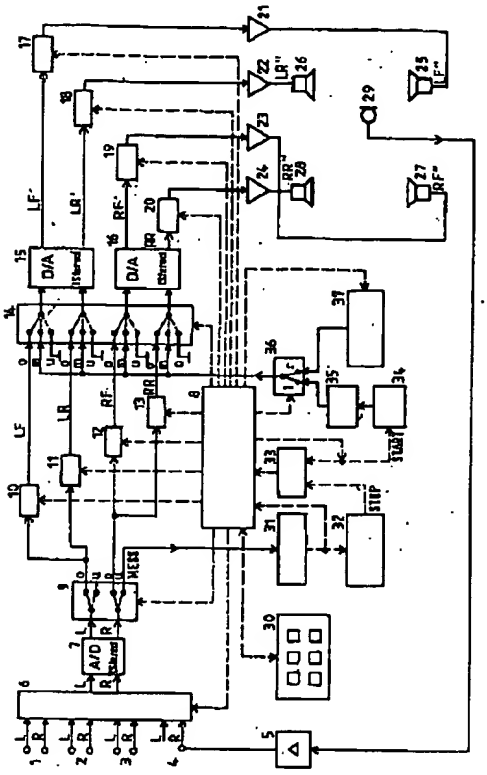

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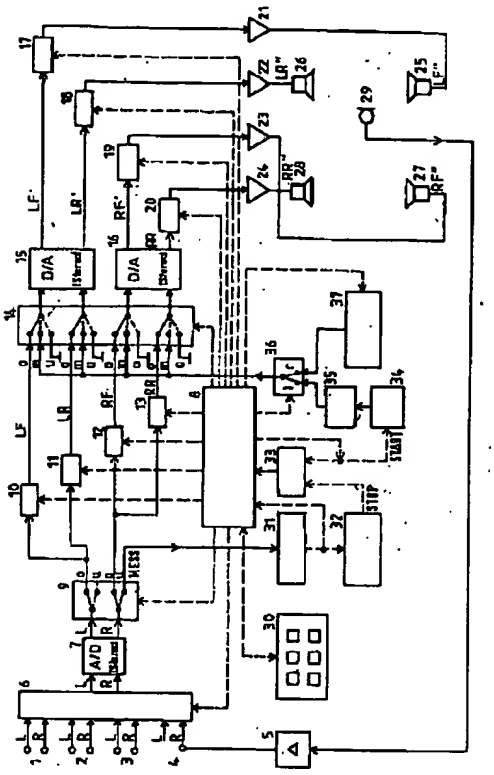

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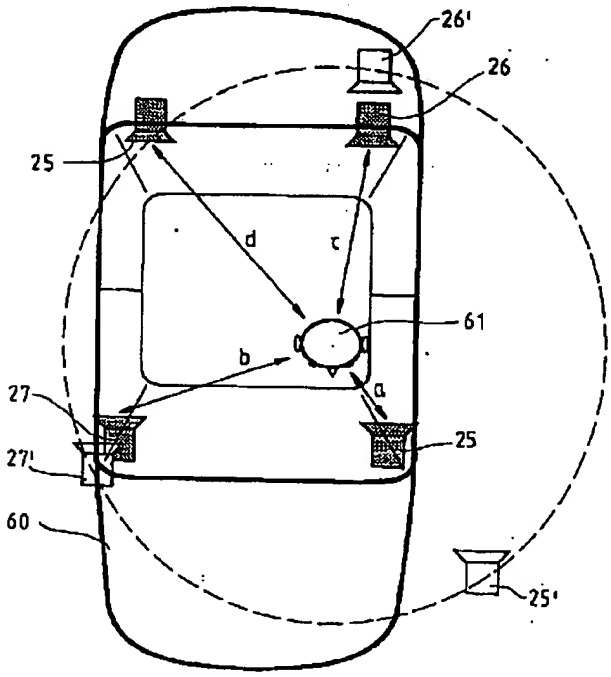
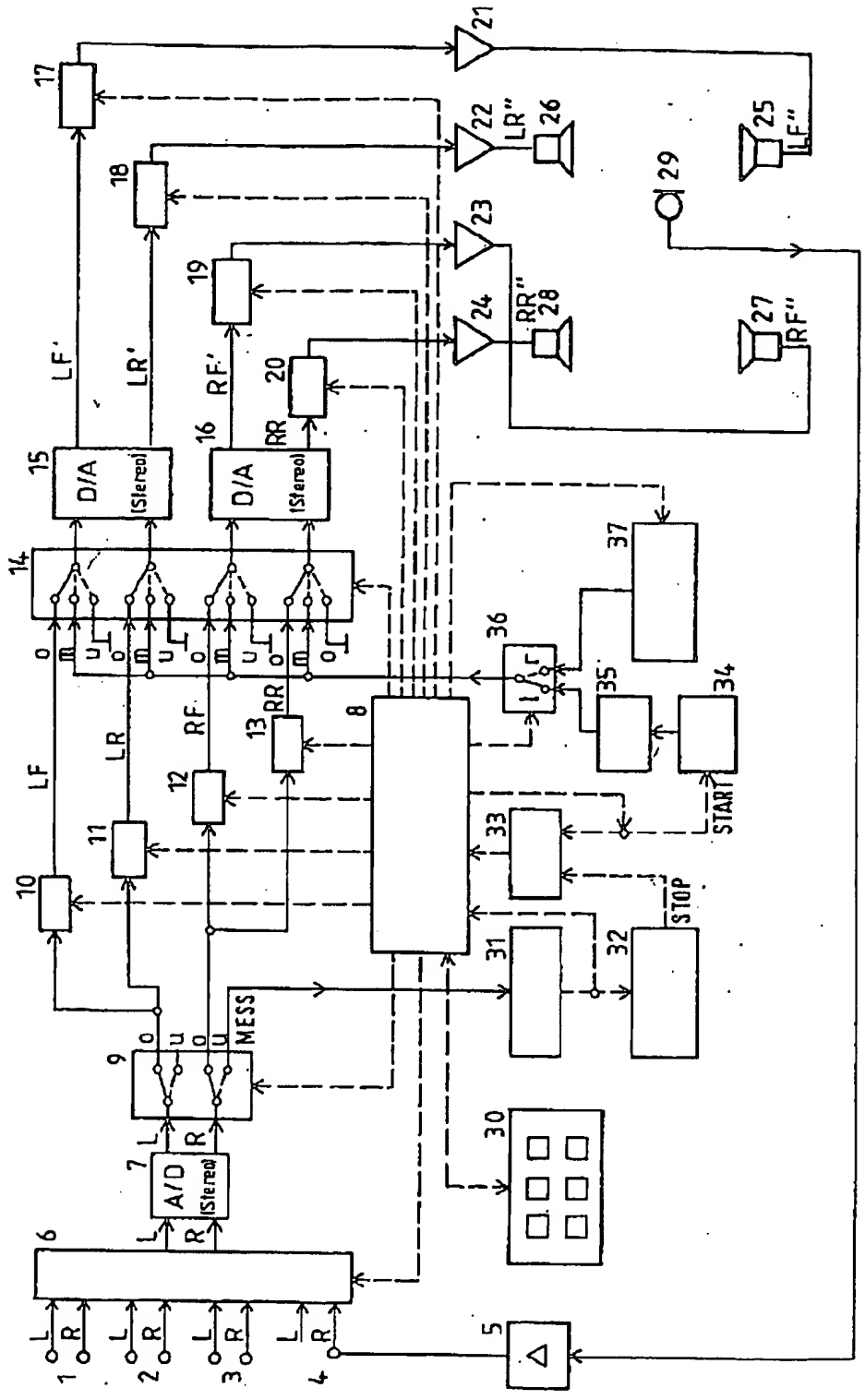
DRAWINGS

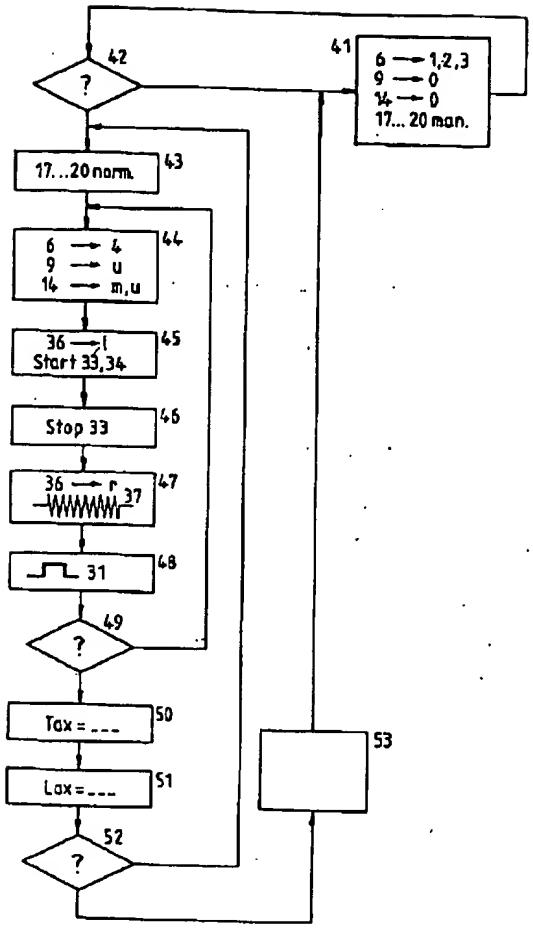
[Drawing 3]



[Drawing 1]


LF'
LR'
RF'
RR
LF
LR
RF
RR
D/A (Stereo)
D/A (Stereo)
A/D (Stereo)
MESS
START
STOP
LR''
RR''
LF''
RF''

[Drawing 2]



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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the block diagram of the equipment by this invention.
[Drawing 2] It is a sequence diagram explaining the sound transit time, the time delay of consecutiveness in a sound-level row, and measurement of volume.
[Drawing 3] It is drawing of the automobile which has the loudspeaker position of the appearance formed of the time delay for these listening positions with four loudspeakers and one operator.
[Description of Notations]
6 Input Switch 4 Stereo / Analog / Digital Converter, 8 Control unit 9 Double transfer switch 10, 11, 12, 13 Delay unit, 15 16 Digital to analog converter 17, 18, 19, 20 Volume setter, 21, 22, 23, 24 Power amplifier 25, 26, 27, 28 loudspeakers, 29 Microphone 30 Display unit 31 Level measuring instrument 32 Threshold discriminator 33 Transit-time measuring instrument 34 A pulse generator, 35 Low-pass path filter 36 Transfer switch 37 Noise source

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